

Draft

NPRM VERSION 17---September 26, 2000

Note: *Bundle II (ANE-99-016-A): Includes compressors Fan & Turbine Shafts (33.27) & Safety & Failure Analysis (33.75). This will not be published until all these associated sections are also ready to be published.*

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts xx,xx,xx

[Docket No. XXXXX; Notice No. XXXXXX]

RIN 2120-XXXX

Airworthiness Standards; Electronic Engine Control System Requirements.....

AGENCY: Federal Aviation Administration, DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: This notice proposes to amend Title 14 of the Code of Federal Regulations (CFR) part 33 (14 CFR 33), Aircraft Engines, § 33.28 Electrical and electronic engine control systems and associated sections §33.5, §33.7, §33.27, §33.29, §33.53, §33.67 and §33.91. This proposal harmonizes the requirements being drafted in conjunction with the Joint Aviation Authorities (JAA) of Europe as part of the Aviation Rulemaking Advisory Committee (ARAC) harmonization activities. The proposed changes if adopted would establish uniform standards for all engine control systems, including electrical and electronic engine control system standards for aircraft engines certified in the United States under 14 CFR part 33 and in the JAA countries under Joint Aviation Requirements-Engines (JAR-E), simplifying airworthiness approvals for import and export.

DATES: Comments to be submitted on or before [TBD date 90 days after the date of publication in the Federal Register].

ADDRESSES: Comments on this notice should be mailed, in duplicate to: Federal Aviation Administration, Office of the Chief Counsel, Attention: Rules Docket (AGC-10), Docket No. , 800 Independence Avenue, SW., Washington, DC 20591. Comments submitted must be marked: "Docket No. ." Comments may be inspected in Room 915G weekdays between 9:00 a.m. and 5:00 p.m. Comments may also be sent electronically to the following internet address: nprmcmts@mail.hq.faa.gov.

FOR FURTHER INFORMATION CONTACT: Cosimo Bosco, Engine and Propeller Standards Staff, ANE-110, Engine and Propeller Directorate, Aircraft Certification Service, FAA, New England Region, 12 New England Executive Park, Burlington, Massachusetts 01803-5299; telephone (781) 238-7118, fax (781) 238-7199.

SUPPLEMENTARY INFORMATION:

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Comments Invited

Interested persons are invited to submit written data, views, or arguments on this proposed rule. Comments relating to the environmental, energy, federalism, or economic impact that might result from adopting the proposals in this notice are also invited. Substantive comments should be accompanied by cost estimates. Comments should identify the regulatory docket number and should be submitted in duplicate to the Rules Docket address specified above.

All comments received on or before the closing date for comments specified will be considered by the Administrator before taking action on this proposed rulemaking. The proposals contained in this notice may be changed in light of comments received.

All comments received will be available, both before and after the closing date for comments, in the Rules Docket for examination by interested persons. A report summarizing each substantive public contact with Federal Aviation Administration (FAA) personnel concerned with this rulemaking will be filed in the docket.

Commenters wishing the FAA to acknowledge receipt of their comments submitted in response to this notice must include a preaddressed, stamped postcard on which the following statement is made: "Comments to Docket No. ." The postcard will be date stamped and mailed to the commenter.

Availability of NPRMs

Any person may obtain a copy of this NPRM by submitting a request to the Federal Aviation Administration, Office of Public Affairs, Attention: Public Inquiry Center, APA-200, 800 Independence Avenue, SW., Washington, DC 20591, or by calling (202) 267-3484. Communications must identify the Notice Number of this NPRM.

Persons interested in being placed on the mailing list for future NPRMs should request from the above office, a copy of Advisory Circular No. 11-2A, Notice of Proposed Rulemaking Distribution System, which describes the application procedure.

Background

The FAA was committed to undertake and support harmonization of the Code of Federal Regulations (CFR) part 33 (14 CFR part 33) with the Joint Aviation Requirements-Engines (JAR-E). As a result of that commitment, the FAA, in cooperation with the JAA, established an engine certification study group to compare part 33 with JAR-E. The original part 33/JAR-E Authorities Engine

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Group was composed of five members, representing airworthiness authorities of the following countries: France, Canada, Germany, the United Kingdom, and the United States.

The initial task of the group was to compare JAR-E with part 33, using part 33, Amendment 11, and JAR-E, Change 7, as the basis for the comparison. The group focused only on gas turbine engines for the initial effort and produced a comparison that noted those JAR-E requirements that appeared to be more restrictive than part 33. The identified differences were grouped into two categories, referred to as List 1 and List 2. List 1 comparison contained those requirements where the differences appeared to be significant, to which the JAA applies additional requirements to the United States manufacturers seeking JAA certification. List 2 comparison contained those requirements that may be considered equivalent based on current FAA practice and interpretations of part 33. Twenty items were classified as List 1, and twenty-four items were classified as List 2.

In August 1989, the FAA and JAA participated in a joint meeting between industry and the airworthiness authorities as requested by the Aerospace Industries Association of America (AIA), and the Association European des Constructeurs de Material d'Aerospatial (AECMA). The purpose of the meeting was to establish a process for resolving List 1 comparison issues.

At the June 1992 FAA/JAA management meeting in Toronto, Canada, seven engine Harmonization Terms of Reference (TOR) items were introduced. These TOR identified potential harmonization projects and four of these TOR were added to the original List 1 of twenty items. Six of the seven TOR have since been selected as Aviation Rulemaking Advisory Committee (ARAC) projects.

Electronic engine controls was one of these TOR contained in List 1 and in August 1994, the FAA tasked ARAC to further evaluate the proposal(59 FR 42323). This task was assigned to the Engine Harmonization Working Group (EHWG) of ARAC.

The EHWG task group, referred to as the Electronic Engine Control Task Group (EECTG), consisting of authorities from the FAA, JAA, Transport Canada (TCA) and industry representatives from the US and JAA countries has been organized. The task group had been assigned the task of harmonizing §33.28, Aircraft Engines Electrical and Electronic Control Systems with JAR-E 50 Controls and associated JAR-E sections. The first meeting of the EECTG was

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held on July 22-23, 1997 at the Direction Generale de l'Aviation Civile (DGAC) offices in Paris, France.

Representatives from the Propeller and Auxiliary Power Unit (APU) harmonization committees were represented on the committee in order to provide an exchange of information between the harmonization task groups to promote commonality.

The FAA has an on-going effort with the reciprocating engine control community to develop policy and advisory material for reciprocating engine controls for general aviation aircraft applications. Outside of the current harmonization effort, AC 33.38-1 is being modified to create a separate advisory circular, AC 33.28-2, that specifically addresses reciprocating engine control systems. Feedback from this effort is being used in the development of harmonized regulations that are applicable to all engine controls including those for reciprocating engines. However, the specific advisory material for reciprocating engines that defines the method of compliance with the harmonized regulations are not sufficiently developed to be included in AC 33.28-1A at this time. The development of guidance material and the harmonization effort for reciprocating engine control systems will be continued after the current harmonization effort is completed if this becomes necessary. Also, separate guidance material will be issued if required.

On [insert date], the EHWG reported their recommendations to the ARAC, which recommended that FAA proceed with rulemaking. This NPRM reflects the ARAC recommendations. A corresponding Notice of Proposed Amendment (NPA) is being published by the JAA.

Statement of the Problem

The existing part 33 and JAR-E regulations for Electronic Engine Controls differ in a number of areas, such as requirements for analysis, software, high intensity radiated fields (HIRF), fire, and lightning. In some cases the JAR-E advisory material is stated as mandatory under § 33.28 requirements, and in other cases, the FAA advisory material is stated as mandatory under the JAR-E requirements. The JAA has published advisory material for electronic engine control systems, while comprehensive FAA advisory material has not been published yet.

In addition, JAR-E requirements address all controls including hydromechanical control (HMC) systems as well as electronic control systems while the current § 33.28 is specific with regard to EEC systems. Therefore, it is

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beneficial to both the regulatory authorities and industry to harmonize the engine control regulations and advisory material. A number of other sections of part 33 were relevant to the certification of engine control systems and were therefore affected by this harmonization effort.

Discussion of the Proposals

The following discussions have been a result of harmonization with the JAR:

Section 33.5

The proposal would amend § 33.5 by adding new paragraphs (a)(4), (a)(5), (a)(6) and (b)(4). These proposed new paragraphs would require installation information to be included in the instructions for installation. The new requirements being proposed in §§ 33.5 (a)(4), (a)(5) and (b)(4) are currently prescribed under the existing § 33.28(a) as part of the control system description. § 33.5(a)(4), § 33.5(a)(5) and § 33.5(b)(4) are harmonized with JAR-E-20(d), JAR-E-30(b) and JAR-E-20(d) respectively.

Proposed new § 33.5(a)(6) would be added to harmonize the requirements of part 33 with the new proposed JAR-E 60(b)(formerly JAR-E 60(c)). The current part 33 does not address a similar requirement that specifies installation information. The proposed new § 33.5(a)(6) would require that the installation instructions must contain the list of instruments necessary for satisfactory control of the engine. Additionally, the overall limits of accuracy and transient response required for satisfactory engine operation must be stated so that the suitability of the instruments as installed can be assessed.

Section 33.7

The proposal would amend § 33.7 by adding a new paragraph (d). This paragraph is added to harmonize part 33 requirements with the last sentence of the current JAR-E 60(c), Provision for Instrumentation. As part of the harmonization effort, the last sentence of JAR-E 60(c) has been redesignated to a more appropriate section in JAR-E 40(g). The proposed new paragraph (d) would require that the overall limits of accuracy of the engine control system and the necessary instruments as defined in § 33.5(a)(6), be considered when determining the engine performance and operating limitations.

Section 33.27

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The existing § 33.27(b) would be redesignated as proposed new § 33.28(b)(3)(i), where it would be more accurately located since the requirement relates to an engine control function.

A new proposed § 33.27(b) would prescribe requirements for methods other than engine control methods for protecting rotor structural integrity during overspeed conditions. These methods, for example, would include protection methods such as blade shedding which are currently regulated under the JAR, but not definitively identified under part 33.

Section 33.28

The current title of § 33.28 is "Electrical and electronic engine control systems". The proposal would revise the title to read "Engine control systems" and would add an "Applicability" paragraph. Currently, § 33.28 only applies to electrical and electronic engine control systems, while JAR-E 50 and associated requirements apply to all types of engine control systems, including hydromechanical and reciprocating engine controls. The proposal would include all types of engine control systems and devices under § 33.28. When harmonizing the engine control requirements, it was necessary to change the title to better reflect the regulatory language that covers all engine control systems.

The existing § 33.28(a) would be revised and redesignated as §33.5, since the prescription of installation requirements are more properly organized into the section dedicated to installation requirements. The proposed requirements for § 33.28(a) would replace the existing requirements, and provide a single section that prescribes the top level requirements for validation of the engine control system. The new proposed format of §33.28(a) would consist of new subparagraphs (a)(1)(i), (a)(1)(ii), and (a)(2).

The proposed new § 33.28(a)(1)(i) would add a requirement that it be demonstrated through engine tests, rig tests, analysis or combinations of these that the engine control system, in its normal and alternative operating modes, perform the intended functions throughout the declared operating conditions and flight envelope. Currently, this is generally required under various paragraphs of part 33, (e.g., §§33.7 and 33.65). Compliance with these engine requirements depends on engine control functions but are not prescribed specifically as engine control system requirements. In addition, this requirement prescribes that the engine control system must perform its intended functions under the declared operating conditions that includes environmental conditions. The proposed new paragraph

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would harmonize the requirements with JAR-E 50 and various engine sections in part 33 that address engine performance and operability requirements.

The proposed new § 33.28(a)(1)(ii) would clarify what is required of fault accommodation implemented through alternate modes, as required in proposed revisions of § 33.28(b) (formerly § 33.28(c)) and § 33.28(d) (formally § 33.28(b)). In addition, the proposed new requirement would clarify the need for crew notification if their action is required as part of the fault accommodation.

The existing § 33.28(d) that addresses environmental limits and transients caused by lightning strikes would be revised and redesignated as proposed new § 33.28(a)(2). The proposed new § 33.28(a)(2) would clarify environmental testing requirements including those for high intensity radiated fields (HIRF), lightning and electromagnetic interference (EMI) for the engine control system. Engine control system environmental limitations are required to be documented in the instructions for installation as required in proposed revision § 33.5. The certification test limits would define the installation limitations for the system.

Proposed revision of existing § 33.28(b), § 33.28(c) and § 33.28(e) would address requirements for aircraft-supplied power and data, system integrity, and software. Although, the intent of these requirements remain unchanged, the text has been clarified and redesignated for harmonization purposes.

The existing § 33.28(c) would be revised and redesignated as new § 33.28(b) and would harmonize with the new proposed JAR-E 50(b). The proposed new § 33.28(b) would clarify the integrity requirements of the engine control system, which is only addressed generally in the existing § 33.28(c). The proposed new § 33.28(b) would consist of four paragraphs. § 33.28(b)(1) would propose regulatory language to address integrity requirements, such as LOTC requirements consistent with the intended application, accommodation of single failures with respect to LOTC and hazardous engine effect, foreseeable failures or malfunctions in the intended aircraft installation (i.e., local events), and failure or malfunctions of shared engine or propeller data or signals.

§ 33.28(b)(2) would propose the requirement for a System Safety Assessment, and § 33.28(b)(3) would propose the requirements for protective functions preserving the integrity of rotors. It is proposed that the existing requirement to protect the integrity of rotors that is currently promulgated under § 33.27(b) be moved to be under the paragraph titled, protective functions, and be redesignated as § 33.28(b)(3). The proposed new § 33.27(b) has been added to harmonize with JAR-E requirements and promulgates that other rotor protection means may be provided, such as blade shedding. The proposed new paragraph §

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33.28(b)(4) would propose requirements for protective functions such as the interlock that inhibits increased thrust until the thrust reverser doors have opened.

The existing § 33.28(e) prescribes the software requirements for the engine control system. Existing section § 33.28(e) would be revised to prescribe that the software be consistent with the criticality of performed functions to harmonize with JAR E-50(c) and redesignated as § 33.28(c).

The existing § 33.28(b) prescribes requirements in the event of failure of aircraft-supplied power or data. The existing segment of § 33.28(b) that prescribes requirements for any failure of aircraft-supplied data would be revised to provide clarified requirements. In addition it would be revised to exempt single engine applications and thrust or power command signals from the aircraft. This segment of § 33.28(b) would be redesignated as § 33.28(d).

The existing segment of § 33.28(b) which prescribes requirements for the loss of aircraft-supplied power would be revised to clarify this requirement and to make it applicable for all electrical power supplied to the engine control system, including that supplied from the aircraft power system and that from the dedicated power source, if required. Requirements for the response of the control system to loss or interruption of electrical power supplied from the aircraft have been clarified. Requirements which have been normal practice but unwritten in the rules have been added. These are: 1) a requirement to define the power characteristics of any power supplied from the aircraft to the engine control system in the instructions for installation; 2) a requirement to define in the instruction for installation, the engine control and engine responses to low voltage transients outside the declared power supply voltage limitations. A requirement is added for the dedicated power source for the control system, if required, to provide sufficient capacity to power the functions provided by the control system below idle, such as for the auto-relight function. The loss of some control functions that have traditionally been dependent on power supplied from the aircraft continue to be acceptable. These continue to be noted in the advisory material. Examples of these control functions are :

- Functions without safety significance that are primarily performance enhancement functions so that, if inoperative, do not affect the safe operation of the engine.
- Engine start and ignition
- Thrust Reverser deployment
- Anti-Icing (engine probe heat)

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- Fuel Shut-Off
- Overspeed Protection Systems

This segment of § 33.28(b) would be redesignated as § 33.28(e).

The proposed new §33.28(f) would add requirements for air pressure signals used in the engine control to harmonize with requirements of the new proposed JAR E50(f)(formerly JAR-E 560(h)). The proposed addition would prescribe that design precautions must be taken to minimize the malfunctioning of the system as a result of the ingress of foreign matter or blockage of the signal lines by foreign matter or ice.

It is proposed that the existing rule 33.67(d) that prescribes requirements for engines with One Engine Inoperative (OEI) capability be moved and be redesignated as 33.28(g). This rule prescribes a control function that more properly is located under § 33.28.

The proposed new §33.28(h) would add requirements for programmable logic devices(PLD) that include Application Specific Integrated Circuits (ASIC) and programmable gates arrays. It was decided to propose a new requirement separate from software requirements, although the requirements are similar, because PLD are a combination of software and complex hardware. The proposed rule would prescribe that the development of the devices and the associated encoded logic used in the design and implementation of these devices be at a level commensurate with the hazard level of the functions performed through the devices.

Minority Positions

One member of the EHWG committee has filed minority positions for the proposed harmonized new § 33.28(d)(1), § 33.28(e) and § 33.28(h). The three minority positions are listed below followed by the FAA response to each minority position.

Minority Position for the Harmonized New § 33.28(d)(1)

The minority position filed for 33.28(d)(1) is stated as follows:

"We object to a new rule being introduced through the advisory material. The rules are currently (see change 10, JAR-E 50, (a)(4):-For turbine engines, the engine control system including a thrust reverser control, if applicable, shall be designed to---Retain the ability to control the engine safely under the appropriate failure conditions determined from the Failure Analysis), and (see FAR 33.28(d):--

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-Each control system which relies on electrical and electronic means for normal operation must: (b) Be designed and constructed so that any failure of aircraft-supplied power or data will not result in an unacceptable change in power or thrust, or prevent continued safe operation of the engine.). The advisory material is currently (See JAR-E, change 10, AMJ 20X-1, section 4.5.5: -Data exchanged with the aircraft, (a) Aircraft must be protected from unacceptable effects of faults due to a single cause, simultaneously affecting more than one engine/propeller. In particular, the following cases should be considered.....(i)Erroneous data received from the aircraft by the engine/propeller control system if the data is common to more than one engine/propeller (e.g. air data sources, auto throttle synchronizing),...and...).

The proposed advisory material defines what is "unacceptable" as a loss of more than 3% requirement of the aircraft (as in the current regulation). The proposed advisory material introduces a "new" requirement, which is a restriction on the design."

FAA Response to the Minority Position for the Harmonized New § 33.28(d)(1)

The minority position claims that the 3% requirement amounts to a new rule introduced through advisory material. The FAA disagrees. The FAA does not intend that this guidance material establish the 3% level as a binding norm. The FAA views an unacceptable change in power or thrust to be one which has a significant affect on the performance margins of the aircraft. The FAA choose, however, not to include a definition of the phrase in the rule, but to offer guidance in this AC. That guidance provides that the FAA will generally not view a change of less than 3% as significant. Changes of 3% or greater will initially be viewed as significant unless the applicant demonstrates otherwise, particularly for engines intended to be installed on aircraft whose designs are certificated under Part 25 rules. The 3% level is similar to the guidance provided for the rain and hail rule.

Therefore, the FAA will proceed with the harmonized new 33.28(d)(1) as proposed.

Minority Position for Harmonized New FAR 33.28(e)

"We object to the introduction of the implied required to comply mandating of a dedicated engine electrical power system. To comply with the existing JARs:---[change 10 JAR-E 50(a)(4) (For turbine engines, the engine control system including a thrust reverser control if applicable, shall be designed to:---Retain the ability to control the engine safely under the appropriate failure conditions

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determined from the Failure Analysis) and AMJ 20-X 4.5.4, (Aircraft electrical power supply. If the aircraft electrical system supplies power to the engine/propeller electronic control system at any time, the power supply quality, including transients or failures, must not lead to a situation identified by the engine manufacturer, which is considered by the aircraft to be a hazard to the aircraft)], it is possible for the control system to solely use aircraft power if the loss/corruption does not lead to as situation considered by the aircraft manufacturer to be a hazard to the aircraft. The "harmonized" rule defines what is intolerable for the engine whereas in our opinion, it should be what is intolerable for the aircraft (as per the current regulations). The proposed advisory material introduces a "new" requirement, which is a restriction on the design.

AMJ 20X 4.2 says that the objective is "The introduction of electronic control systems should provide for the aircraft at least the equivalent safety, and the related reliability level, as achieved by engines/propellers equipped with hydromechanical control and protection system". The objective is not stated as providing a particular level of independence of the engine control system from the aircraft, which is what this "new" regulation is doing."

FAA Response to Minority Position for Harmonized New § 33.28(e)

The commenter states that this rule is a "new" requirement when referred to JAR E-50(a)(4) and AMJ 20X-1. However, this requirement exists in the current § 33.28(b) and is not new. An analysis of an aircraft power bus system may conclude that there is adequate reliability, because redundant systems do allow individual paths to have somewhat poor reliability. However, it has been the experience of the FAA that complete power losses do occur on aircraft within the life of a given fleet. This is because the analysis may not consider all the potential failure modes to which the power bus and power source are exposed. Consequently, the FAA has required that the engine continue to operate with the loss of aircraft-supplied power. The ARAC harmonization process is intended to bring the FAR and JAR into agreement. In some cases the FAR has been changed to agree with the JAR. In this case the JAR has been changed to agree with the FAR because the EECTG committee agreed that this provided the better safety objective.

Minority Position for Harmonized New § 33.28(h)

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"We object to the introduction of this topic via the harmonization activity. We agree that the topic needs to be addressed through regulations but the harmonization activity is not the appropriate method to introduce new regulations. Currently a draft FAA issue paper and JAA CRI on this subject are being prepared. It is being written by experts in the field and it is the intention for this to be considered as a new regulation."

FAA Response to the Minority Position for Harmonized New § 33.28(h)

The draft PLD generic issue paper provided by the FAA has been the basis of issue papers written on current certification programs. The draft JAA CRI is similar to the FAA drafted generic issue paper. In addition, RTCA/DO-254 Design Assurance Guidance For Airborne Electronic Hardware that addresses acceptance of PLDs in certification programs was issued on April 19, 2000. It is anticipated that the FAA and JAA will both accept this document as an AC that will provide guidance for the acceptance of PLDs. Methodology described in these documents can be used to demonstrate compliance with § 33.28(h);.

In addition, the authority for the acceptance of the software for PLDs currently is promulgated in existing § 33.28(e). However, it is more appropriate to prescribe a requirement for PLDs considered as complex hardware using methodology similar to that used for software to demonstrate compliance. The harmonization activity provides an opportune time to prescribe harmonized requirements for acceptance of PLDs rather than to continue the use of issue papers or policy memorandums.

Therefore, the FAA disagrees with the commenter's minority position and will move forward with the § 33.28(h).

Section 33.29

The proposed revision of § 33.29, would add new paragraphs (d) through (f) to harmonize the part 33 requirements with JAR-E 60 Provision for Instruments.

The proposed addition of § 33.29(d) would harmonize the requirements of part 33 with JAR-E 60(a), since the current part 33 does not provide for a similar requirement. The proposed revision would prescribe that provision be made for instrumentation necessary to ensure operation in compliance with the engine operating limitations. When the instrumentation is necessary for compliance with

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the engine requirements, the instrumentation must be specified in the instructions for installation and included as part of the engine type design.

The proposed new § 33.29(e) would harmonize the requirements of part 33 and the new JAR-E 110(e). The existing § 33.29(a) requirement addresses the prevention of incorrect connections of instruments only, and the new § 33.29(d) would harmonize with the JAR by requiring a means be provided to minimize the possibility of incorrect fitting of instruments, sensors and connectors.

The proposed new § 33.29(f) would harmonize the requirements of part 33 and the existing JAR-E 60(c). Currently, the part 33 does not address requirements for sensors and associated wiring and signal conditioning segregation. The proposed new requirement would reduce the probability of faults propagating from the instrumentation and monitoring functions to the control functions, or vice versa, by prescribing that the probability of propagation of faults be consistent with the criticality of the function performed.

Section 33.53

The existing title of § 33.53 is "Engine component tests", and the proposal would revise the title to read "Engine system and component tests". The proposed revision to the title would better identify reciprocating engine control system tests that may be conducted under this paragraph. System validation testing, for example, may be required under this paragraph.

Section 33.67

The existing § 33.67(d) would be redesignated as proposed new §33.28(g), where it would be more accurately located since the requirement relates to an engine control function. The existing § 33.67(d) had recently been changed as part of the Part 33/JAR-E harmonization effort for the OEI requirements. There is no change in the text of the rule being redesignated.

Section 33.91

The existing title of § 33.91 is "Engine component tests", and the proposal would revise the title to read "Engine system and component tests". The proposed revision to the title would better identify engine control system tests that may be conducted under this paragraph. System validation testing, for example, may be required under this paragraph.

The proposal would revise § 33.91(a) to provide for systems tests if required.

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Advisory material that defines environmental tests typically conducted for EEC systems is provided in a policy memorandum that will subsequently be integrated into AC33.2B Aircraft Engine Type Certification Handbook .

Paperwork Reduction Act

TBD

Regulatory Evaluation Summary

TBD

International Trade Impact Analysis

TBD

Regulatory Flexibility Determination

TBD

Federalism Implications

TBD

The Proposed Amendments

In consideration of the foregoing, the Federal Aviation Administration proposes to amend part 33 of Title 14, Code of Federal Regulations as follows:

PART 33-AIRWORTHINESS STANDARDS: AIRCRAFT ENGINES

1. The authority citation for part 33 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701-44702, 44704.

2. Section 33.5 is amended by adding new paragraphs (a)(4), (a)(5), (a)(6), and (b)(4), to read as follows:

(a) * * *

(3) * * *

(4) A definition of the physical interfaces with the aircraft and aircraft equipment, including the propeller when applicable.

(5) Where a system certified with the engine relies on components which are not part of the engine type design, the system and interface requirements upon which engine type certification is based must be specified in the engine instructions for installation directly, or by reference to appropriate documentation, available to the aircraft installer, containing these requirements.

(6) A list of the instruments necessary for control of the engine, including the overall limits of accuracy and transient response required of such instruments to control operation of the engine.

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(b) * * *

(3) * * *

(4) A description of the operational modes, including limitations, of the engine control system and its functional interface with the aircraft systems, including the propeller when applicable.

3. Section 33.7 is amended by adding new paragraph (d) to read as follows:

(c) * * *

(d) In determining the engine performance and operating limitations, the overall limits of accuracy of the engine control system and of the necessary instrumentation as defined in §33.5(a)(6) will be taken into account.

4. Section 33.27 is amended by revising the existing paragraph (b) to read as follows:

(a) * * *

(b) The design and functioning of engine systems, instruments, and other methods, not covered under 33.28 of this part, must give reasonable assurance that those engine operating limitations that affect turbine, compressor, fan, and turbosupercharger rotor structural integrity will not be exceeded in service.

5. Section 33.28 is amended by revising the title of § 33.28, introductory text and revising and redesignating paragraphs (a), (b), (c), (d) and (e), and adding new paragraphs (a)(1), (a)(2), (b)(1), (b)(2), (b)(3), (b)(4), d(2), e(2), e(3), e(4), (f), (f)(1),(f)(2), (g), and (h).

Section 33.28 Engine control systems.

Applicability: These requirements are applicable to any system or device, that is part of engine type design, that controls, limits or monitors engine operation, and is necessary for continued airworthiness of the engine.

(a) Validation.

(1) Functional Aspects.

(i) Control Modes. It must be substantiated by engine tests, rig tests, analysis or a combination thereof, that the engine control system performs the intended functions throughout the declared operating conditions and flight envelope in a manner which;

1. allows the engine to be controlled within its operating limits,

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2. complies with the operability requirements of § 33.51, §33.65 and §33.73, under all likely system inputs and allowable engine power or thrust demands, unless it can be demonstrated that this is not required in the intended application, and
3. allows modulation of engine power or thrust with adequate sensitivity over the required range of engine operating conditions, and
4. does not create unacceptable power or thrust oscillations.

FAR 33.28(a)(1) applies to the primary control mode and to those alternative or back-up control modes, as described under § 33.5(b)(4) for which the applicant wishes to take LOTC credit, and are necessary for compliance with § 33.28(a)(1)(i). Data obtained from any FAR 33 certification test may be used to substantiate control mode requirements.

(ii) Control Mode Transitions. It must be demonstrated that, when fault accommodation results in a control mode change, the transition occurs so that;

1. the engine does not exceed any of its operating limitations, and
2. the engine does not surge, stall or experience unacceptable thrust or power oscillations or other detrimental characteristics, and
3. the magnitude of any change in thrust or power and the associated transition time are identified and described in the engine instructions for installation and operation.

In addition, if a flight crew action is required in the mode change, provision for a means to alert the crew must be provided and the crew action must be defined in the engine instructions for installation and operation.

(2) Environmental Limits. It must be demonstrated, when complying with § 33.53 or § 33.91, that the engine control system functionality will not be adversely affected by declared environmental conditions, including electromagnetic interference (EMI), HIRF and lightning. The limits to which the system has been qualified shall be documented in the engine instructions for installation.

(b)(1) The control system must be designed and constructed so that:

- (i) a rate for Loss of Thrust (or power) Control (LOTC) events consistent with the intended application can be achieved, and
- (ii) in the full-up configuration, the engine control system is essentially single fault tolerant for electrical or electronic failures with respect to LOTC events, and

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(iii) single failures of an electrical or electronic components shall not result in a hazardous engine effect as defined in §33.75, and

(iv) foreseeable failures or malfunctions in the intended aircraft installation which might affect elements of the engine control system, such as fire, overheat, or failures leading to damage to engine control system components do not result in a hazardous engine effect as defined in §33.75 due to engine control system failures or malfunctions, and

(v) if applicable, the failure or corruption of engine or propeller data or signals shared between engines do not cause an unacceptable change in thrust or power.

2) An System Safety Assessment that demonstrates compliance with FAR 33.28 is required. This assessment must identify faults that result in a change in thrust or power, a transmission of erroneous data, or an effect on engine operability. The analysis must contain the predicted frequency of occurrence of these faults.

(3) Overspeed Protection Function.

(i) The design and functioning of the engine control devices, systems, together with the engine instruments and operating and maintenance instructions, must provide reasonable assurance that those engine operating limitations that affect turbine, compressor, fan, and turbosupercharger rotor structural integrity will not be exceeded in service.

(ii) When electronic overspeed protection systems are provided for compliance with 33.28 (b)(3)(i), the design must include a means for testing, at least once per engine start/stop cycle, to ensure the availability of the protection function. If the test is not fully automatic, the requirement for this periodic manual test must be contained in the engine instructions for operation.

(4) The predicted failure rate of protective functions provided by the engine control system must be consistent with the safety analysis associated with those functions.

(c) For electronic engine control systems, all associated software must be designed, implemented and verified to minimize the existence of errors by using a method, approved by the Administrator, that is consistent with the criticality of the performed functions.

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- (d) For engines intended to be installed in a multi-engine aircraft,
 - (1) Engine control systems which use aircraft-supplied data must be designed to accommodate circumstances where some or all of the data are lost, corrupted or failed in any manner. The accommodation strategy must not result in an unacceptable change in thrust or power, a hazardous engine effect as defined in §33.75, or an unacceptable change in engine operating characteristics. The effect of the failure of aircraft-supplied data on the engine's output power or thrust characteristics throughout the flight envelope shall be evaluated and documented. This requirement does not apply to thrust or power command signals from the aircraft, unless these signals produce a hazardous engine effect.
 - (2) For engines intended for single engine applications, the effects of loss, corruption or failure of aircraft supplied data must be included in the engine control system's safety and LOTC analyses required under § 33.28 (b).
- (e) *Electrical power.*
 - (1) The engine control system must be designed so that, after the engine is started and operating at idle or above, the loss or interruption of electrical power supplied from the aircraft to the engine control system will not result;
 - (i) in a hazardous engine effect or,
 - (ii) an unacceptable effect in thrust or power, or any effect on engine operating characteristics as required by §33.51, §33.65 and §33.73, as applicable or
 - (iii) the transmission of erroneous data.
 - (1) When an engine dedicated power source is required for compliance with the §33.28(e)(1), its capacity should provide sufficient margin to account for engine operation below idle where the control is designed and expected to recover engine operation automatically.
 - (2) The need for, and the characteristics of, any electrical power supplied from the aircraft to the engine control system for starting and operating the engine, including transient and steady state voltage limits, must be identified and declared in the engine instructions for installation.
 - (1) Low voltage transients outside of the power supply voltage limitations declared in §33.28(e)(3), must not result in a permanent loss of function or an inappropriate operation of the engine control system which could cause the

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engine to exceed any operational limitation, result in a hazardous engine effect as defined in § 33.75, or cause the transmission of erroneous data. The engine control system must resume normal operation when aircraft-supplied power returns to within the declared limits.

(f) Where an air pressure signal is used by the engine control system and could affect engine operation, design precautions must be taken to minimize:

- (1) Malfunctioning of the system as a result of the ingress of foreign matter, and
- (2) Blockage of the signal lines by foreign matter or ice.

(g) Engines having a 30-Second OEI Power rating must incorporate means or provision for means for automatic availability and automatic control of the 30-Second OEI power within its operating limitations.

(h) The development of programmed devices using digital logic or other complex design technologies must provide a level of assurance for the encoded logic which is commensurate with the hazard associated with the failure or malfunction of the systems in which the devices are located. All associated logic must be designed, implemented and verified to minimize the existence of errors by using a method approved by the Administrator, that is consistent with the criticality of the performed function.

6. Section 33.29 is amended adding new paragraphs (d) through (e) to read as follows:

(a) * * *

(b) * * *

(c) * * *

(d) Provision must be made for the installation of instrumentation necessary to ensure operation in compliance with engine operating limitations. When presenting the failure analysis, or complying with any other requirement, if dependence is placed on instrumentation which is not otherwise mandatory in the assumed aircraft installation, then this instrumentation must be specified in the engine instructions for installation and declared mandatory in the engine approval documentation.

(e) Means must be provided to minimize the possibility of incorrect fitting of instruments, sensors and connectors.

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(f) The sensors, together with associated wiring and signal conditioning, must be segregated, both electrically and physically, to the extent necessary to ensure that the probability of faults propagating from instrumentation and monitoring functions to control functions or vice versa is consistent with the criticality of the performed functions.

7. Section 33.53 is amended by revising the title and paragraph (a) as follows:

§ 33.53 Engine system and component tests.

(a) For those systems and components which cannot be adequately substantiated by endurance testing of FAR 33.49, additional tests must be conducted to demonstrate that systems or components are able to perform the intended functions in all declared environmental and operating conditions.

8 Section 33.67(d) is deleted from this section and added to amended Section 33.28 as § 33.28(g).

9. Section 33.91 is amended by revising the title and paragraph (a) as follows:

§ 33.91 Engine system and component tests.

(a) For those systems or components which cannot be adequately substantiated in accordance with endurance testing of § 33.87, additional tests must be conducted to demonstrate that the systems or components are able to perform the intended functions in all declared environmental and operating conditions.

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